690 - Some Recent Highlights

- Some recent planetary highlights in SSED at GSFC:
  - Successful landing of Curiosity on Mars and initial operations of SAM
  - Successful launch of RBSP with two magnetometers from 690
  - JUNO on the way to Jupiter with magnetometers from 690
  - Developing the next New Frontiers mission (OSIRIS-REX) with LM and U Arizona
  - Lunar Reconnaissance Orbiter approved for a two-year Extended Science Mission
  - Many instruments in flight operations and data analysis (e.g. Cassini CIRS)
  - Pioneering laboratory research (astrobiology, etc.)
  - 17 NASA Agency Honor Awards

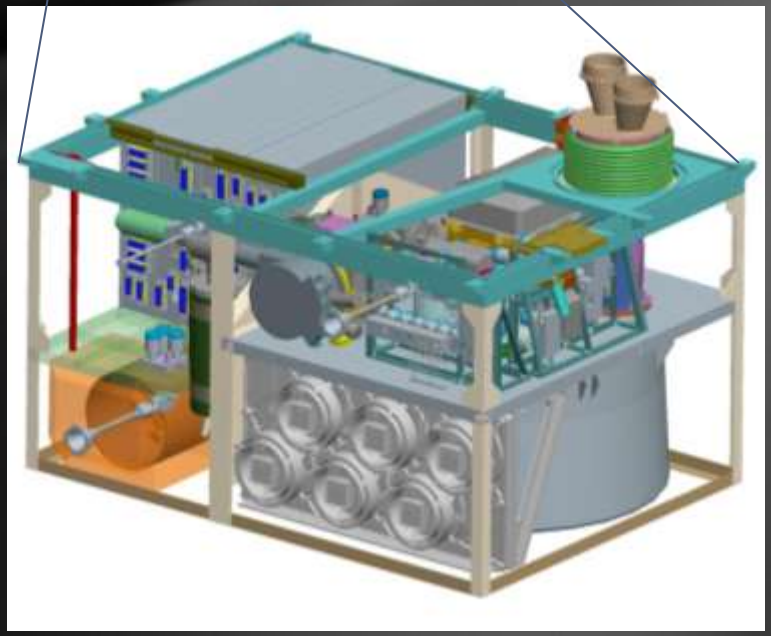
More information at: http://science.gsfc.nasa.gov/solarsystem/

Goddard's SAM and MSL's science goals

- **Assess biological potential of at least one target environment (past or present).**
  - Determine the nature and inventory of organic carbon compounds **(SAM G1, G2)**
  - Inventory the chemical building blocks of life (C, H, N, O, P, S) **(SAM G3)**
  - Identify features that may record the actions of biologically-relevant processes

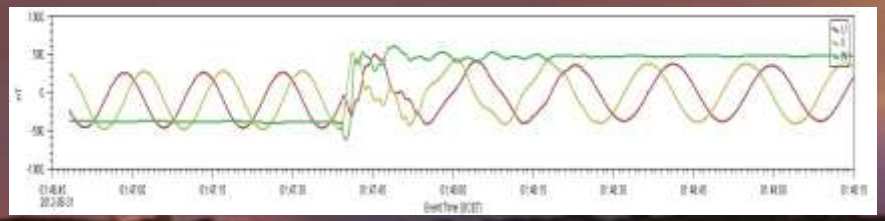
- **Characterize the geology of the landing region at all appropriate spatial scales**
  - Investigate the chemical **(SAM G3)**, isotopic **(SAM G3)**, and mineralogical composition of martian surface and near-surface geological materials
  - Interpret the processes that have formed and modified rocks and regolith **(SAM G3)**

- **Investigate planetary processes that influence habitability**
  - Assess long-timescale (4-billion-year) atmospheric evolution processes **(SAM G5)**.
  - Determine present state, distribution, and cycling of water and CO_2 **(SAM G4)**



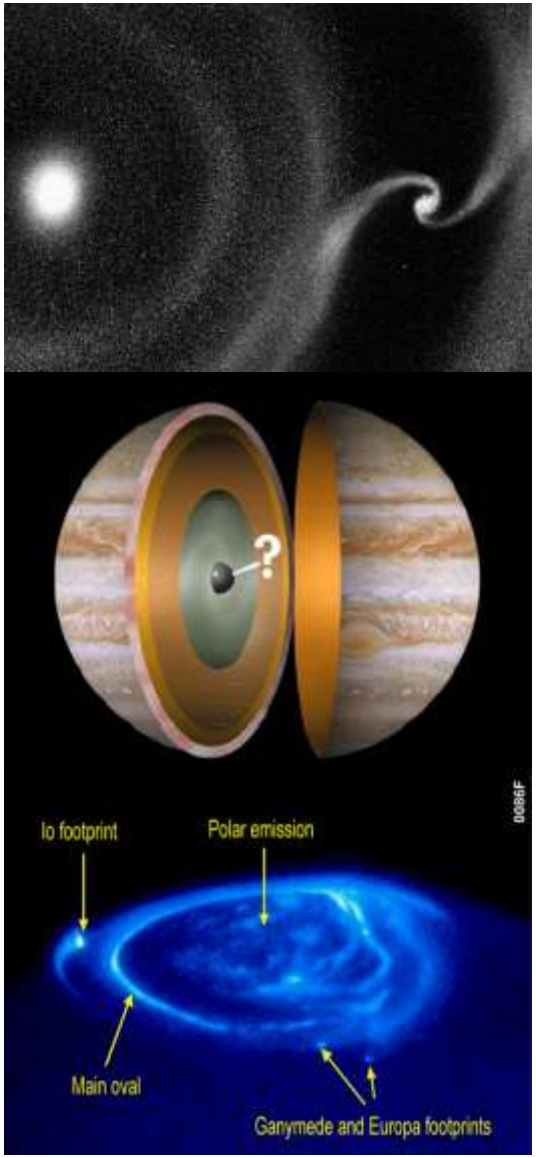
Radiation Belt Storm Probes (RBSP)

- Successfully launched August 30, 2012.
- Two multi-instrumented spacecraft to enhance understanding of particle acceleration, transport, and loss in the terrestrial radiation belts.
- A specific focus is the dynamics of the radiation belts during geomagnetic storms, in response to variations in the solar wind.
- The GSFC magnetometer group, led by Code 695, built two magnetometers for the RBSP spacecraft.
- Figure below shows 3 components of magnetic field during boom deployment on RBSP-B at 1:48 AM, 8/31.



Juno Science Questions

- Origin – What is the O/H ratio (water abundance), how does it constrain the mass of the Jovian core, and which theories of solar system origin are consistent with these results?
- Interior – What are the structure and dynamical properties of Jupiter's interior, based on mapping of the gravitational and magnetic fields?
  - **GSFC Magnetometer team built the Juno magnetometers**
- Atmosphere – What does mapping of variability in atmospheric composition, temperature, cloud opacity and dynamics tell us about weather on Jupiter?
- Polar Magnetosphere – What is the 3-D structure of Jupiter's polar magnetosphere and how does it affect the Jovian aurorae?



Exploring Our Past, Securing Our Future

Launch in 2016—Encounter in 2019—Return in 2023

OSIRIS-REx

Asteroid Sample Return Mission

PI: Dante Lauretta (U. Arizona)

Science Objectives and Goddard's involvement:

Return and Analyze a Sample
Glavin (699), Dworkin, Elsila-Cook, Callahan (691)

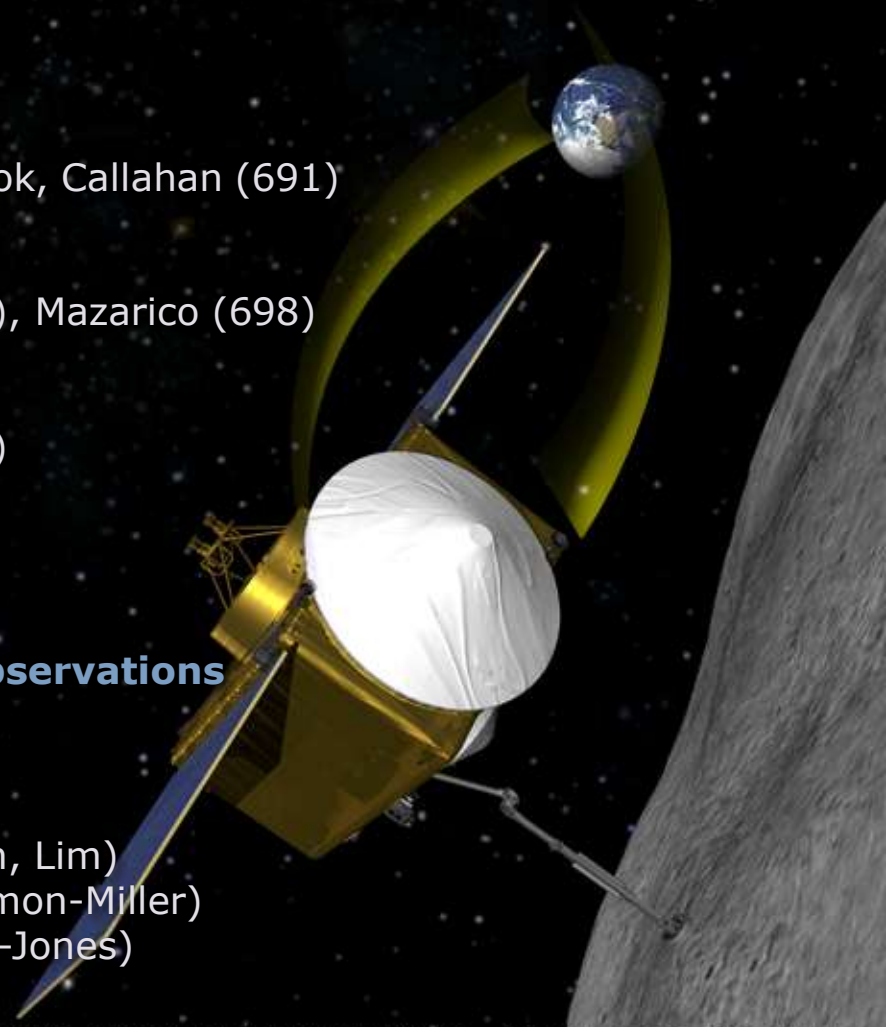
Create Maps of the Asteroid
Reuter (693), Simon-Miller (690), Mazarico (698)

.

Document the Sample Site
Reuter (693), Simon-Miller (690)

Measure the Orbit Deviations
Rowlands (698)

Compare to Ground-based Observations
Lim (691)



690 Major Goddard Deliverables:

Project Science (Dworkin, Nuth, Lim)
OVIRS Instrument (Reuter, Simon-Miller)
E/PO; PAO (Bleacher, Hsu; Neil-Jones)

THE UNIVERSITY OF ARIZONA • NASA GODDARD SPACE FLIGHT CENTER • LOCKHEED MARTIN

Lunar Reconnaissance Orbiter (LRO)

- LRO operations have been approved for a two-year Extended Science Mission through September, 2014.
- The new science for the ESM is organized around four themes aligned with Planetary Decadal Survey themes:
  1. The Nature of Volatiles Deposited in the Moon's Polar Regions
  2. Terrestrial Planet Differentiation and Early Evolution
  3. The Lunar Impact Record and its Relation to Solar System History
  4. The Moon's Interaction with its External Environment

The Moon is a natural laboratory for solar system processes and the ESM is optimized to increase our understanding of it.

Taurus-Littrow Valley, Apollo 17 landing site

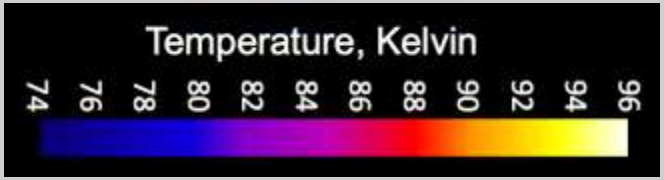
Cassini mission

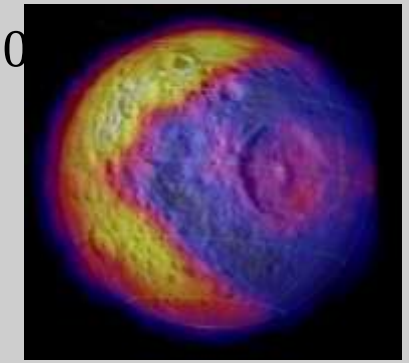
Goddard's Composite Infrared Spectrometer (CIRS)

Science Highlights

- Discovery of an intense zonal jet in Jupiter's stratosphere (2001)
- Discovery of a strong circumpolar vortex about Titan's winter north pole (2005)
- Discovery of anomalous thermal mission from the large fissures in the south polar region of Enceladus (2005)
- Discovery of an equatorial oscillation on Saturn (2006)
- Discovery of the Pac-Man feature on Mimas, indicating an anomalous region of low thermal inertia near the Herschel crater (2010)
- Outbreak of Saturn's giant northern mid-latitude storm (2010

Mimas Pac-Man feature:





Goddard's Astrobiology Analytical Lab (691/699)

Jason Dworkin, Daniel Glavin, Jamie Elsila, Jennifer Stern,
Michael Callahan, Mildred Martin, Aaron Burton, Karen Smith, José Aponte

- Compelling evidence **nucleobases** & **amino acids** are indigenous in carbonaceous meteorites.
- Meteorites may have amplified and delivered **chiral excesses** in the early Solar System.
- These and other compounds in meteorites increases the likelihood of **life elsewhere**.

Dark Cloud

Solar Nebula

Parent Body Processing

Delivery

CM group

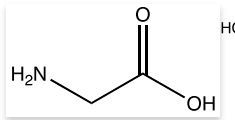
CI group

CR group

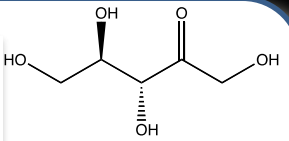
CV group

& CO, CK ureilite, etc.

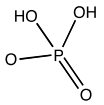
Aqueously or **Thermally Processed Meteorites**



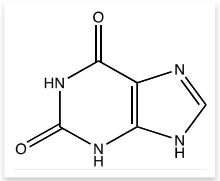
Amino Acids



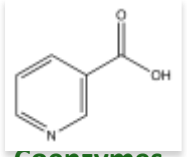
Polyols



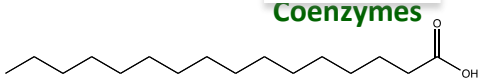
Phosphates



Nucleobases

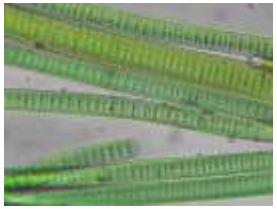


Coenzymes



Carboxylic Acids

Meteoritic Biomolecules



Life on Earth

Life Elsewhere?

690 - NASA Agency Honor Awards

- **Outstanding Leadership Medal** Jason Dworkin
- **Exceptional Service Medal** Mike Flasar; Frank Ottens
- **Exceptional Scientific Achievement Medal** Bill Farrell; Rich Vondrak
- **Exceptional Technology Achievement Medal** Bryan Blair
- **Early Career Achievement Medal** Carrie Anderson; Michael Callahan; Jamie Cook; Noah Petro; Melissa Trainer
- **Exceptional Public Achievement Medal** Andrea Jones
- **Exceptional Public Service Medal** Christopher Johnson; Marcia Segura
- **Silver Achievement Medal (Individual)** Paul Mahaffy
- **Group Achievement Award** Juno Magnetometer Team; The JUNO Team